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Ask a CTBUH Expert: Lisa Podesto

How Does Mass Timber Improve Tall Construction Productivity and Sustainability?

The future of building construction is being shaped most significantly by two factors: the knowledge that the construction industry suffers from a severe lack of productivity improvement, averaging one percent growth per year over the last two decades, and the inescapable reality that buildings are the source of more than one-third of the world's carbon dioxide emissions. CTBUH asked an expert how mass timber can address both these issues.

Industrializing Construction

The Empire State Building took just over 13 months to build in 1930, and yet today we can't complete a typical mid-rise housing project in the same time period. McKinsey Global Institute's report (Barbosa, et al. 2017) highlights why and how we could tackle the root causes that underlie the industry's poor productivity. The reason mass timber is such a key to construction efficiency is because it incorporates some aspect of each of these levers for higher productivity, either directly or indirectly.

- **Reshape regulation and transparency.** The new International Building Code (IBC) provisions for mass timber represented a dramatic reshaping as the most significant code change since its inception. While these codes are prescriptive, authorities are quickly recognizing the value of performance-based fire and structural engineering approaches, which provide a means for objective-based design.

- **Rewire the contractual framework.** Mass timber projects require a collaborative approach, due to so many design interdependencies (fire, structure, aesthetics, acoustics, etc.).Therefore these projects are exploring new contract arrangements, such as design build and integrated project delivery. The up-front engagement of trades reduces the number of design iterations and improves productivity.

- **Rethink design and engineering processes.** The financial success of a mass timber project is tied to high levels of repeatability, both within the project itself, and from project to project, which is a much different approach to the traditional one-off design approach. The value of timber on a per-volume basis all but forces the designer to prioritize the manufacturing efficiency and constantly consider the waste factor. Off-site prefabrication and manufacture of other non-timber components is also synergistic with a mass-timber structure, both because of the dimensional stability and accuracy of the material, and also because of the pre-planning and on-site equipment already necessary to deliver the structure.

- **Improve procurement and supply chain management.** Many mass timber factories are highly automated, with manufacturing and fabrication reliant on Design for Manufacture and Assembly (DfMA) techniques. Digitally-enabled procurement improves planning and transparency between contractors and suppliers, providing precise models with high levels of development (LOD) for quicker procurement and project execution. The repetition or "kit of parts" approach instituted on mass timber projects also provides predictability and can drive economies of scale for the supply chain.

- **Improve on-site execution.** Mass timber's large-panel components, with fewer details and unique connectors, reduce the complexity of site assembly and the total number of parts compared to conventional construction. Fewer, more-standardized parts allow for interchangeability, more predictable outcomes, and easier quality control. Because of these advantages, we've seen reductions of 30-50 percent in on-site labor hours, and schedule reductions of over 30 percent. Companies like Lendlease's Podium MX Studio are capturing even deeper labor and schedule savings through a special prototype testing process called Design for Site Assembly (DfSA).

- **Infuse digital technology, new materials, and advanced automation.** Digital twins, generative models, automated design solvers, and integrated software platforms with real-time cost capabilities are at the core of businesses like Lendlease Podium. These technology leaps couple very well with DfMA-enabled physical products like mass timber, and are often embraced with these new materials.

- **Reskill the workforce.** Skilled construction labor is disappearing. In response, we need to increase productivity by training a 21st -century construction workforce with a flexible skillset that transcends traditional trade scopes and is transferable across building components. Because mass timber structures are ideal for componentized delivery, a single crew of well-trained installers and a crane can assemble a structure, façade, and MEPF system that are designed to be plug-and-play. Through DfSA, installers can be trained in these techniques to improve their productivity while also improving safety and ergonomics.

Planet-Forward Approach

More companies like Lendlease are committing to net-zero carbon targets, and using timber is a key part of the strategy to achieve them. While efforts will continue to be made to reduce operational carbon through better energy efficiency and cleaner energy sources, a greater emphasis is being put on reducing the embodied carbon, recognizing that carbon emissions avoided today are of more immediate value than those saved over the long term.

Because a building's structure and foundation make up over half of its embodied carbon footprint, it is the most obvious place to target for reductions. Every metric ton of wood used in place of concrete and steel in the structure is estimated to avoid 3.9 metric tons of CO_2 emissions (WoodWorks 2021). On top of offsetting carbon emissions in the above-ground structure, mass timber buildings are 40 to 60 percent lighter than traditional heavy construction materials, helping to further reduce the amount of carbon (i.e., concrete) in the substructure. On Forte', Lendlease first CLT project in Melbourne (see Figure 1), the company was able to avoid over two-thirds of the carbon dioxide emissions compared to the project being built in concrete. And this doesn't even account for the 761 metric tons of carbon stored in the timber used in the building.

What cannot be accounted for in the life-cycle assessment (LCA) for a single building is the potential carbon "storage vault" mass timber infrastructure offers. While mature forests are maximizing their carbon storage, growing forests are maximizing their carbon sequestration. By sustainably harvesting trees off the landscape, and storing that carbon in the wood for the life of the building, we allow forests to sequester carbon more rapidly from the atmosphere and avoid releasing a large portion of the carbon stored in the removed trees. Worldwide, natural climate solutions could mitigate more than one-third of the emissions needed to hit our global targets by 2030, with forests and improved land management being the largest contributors (Alberts 2020).

Figure 1. Forté, a 10-story, 32-meter concrete-timber hybrid building completed in Melbourne in 2012, cut its emissions by more than 66 percent by strategically using timber instead of concrete in its structure. © Lendlease

Forests in North America are increasing in density, and ongoing drought and disease have created a perfect storm for unprecedented wildfires and tree mortality, threatening one of the largest natural vehicles for terrestrial carbon storage the planet has. For instance, California wildfires in 2021 emitted carbon dioxide exceeding 25 percent of the state's annual fossil fuel consumption. Mass timber products offer a way to remove these dangerous fuel loads from the landscape without releasing them into the atmosphere, because it utilizes lower-value/smaller-diameter trees, which don't typically have enough economic value to be removed otherwise.

Transforming our cities into a terrestrial carbon sink, and allowing our forests to maintain their sequestration potential is the aspiration. With the ability to reduce carbon emissions, improve global carbon sequestration, and improve construction productivity, mass timber presents a unique opportunity to change the future of construction. ■

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About the Author

Lisa Podesto is senior business development manager, Design-Build Americas and Podium MX for Lendlease. She is a professional engineer with over a decade of experience in market development for wood structures, responsible for advising construction, development, and design-build projects throughout the United States, where the use of mass timber and componentized solutions are being considered.

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